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Is 17 Leporis a Shell Star?

by

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NOTES FROM OBSERVATORIES

IS 17 LEPORIS A SHELL STAR?

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Infra-red shell stars. There is abundant spectroscopic evidence that a good many stars are losing mass through slow continuous expansion of their outer atmospheres. When the stellar material has moved to a sufficient distance from its parent star, solid particles may condense; the star then becomes reddened and the energy thus absorbed is reradiated at wavelengths beyond $1\text{ }\mu\text{m}$. We shall, for simplicity, refer to such objects as infra-red shell stars, without wishing to imply that their circumstellar dust clouds take the form of a closed shell entirely enveloping the star. Current data suggest that the infra-red shell stars fall into two categories.

The first category and best studied group of infra-red shell stars is the late-type giants and supergiants. A great many were recorded in the two-micron infra-red catalogue (IRC)¹. Carbon-rich stars produce black-body shells which are attributed to graphite grains. Oxygen-rich stars produce narrow emission features at 10 and 20 μm which are tentatively assigned to silicate molecules². There is mounting evidence^{3,4} that the intensity of this emission feature depends on both temperature and luminosity (gravity). Thus a late-type supergiant usually exhibits an intense ten-micron excess while an Mo giant shows none.

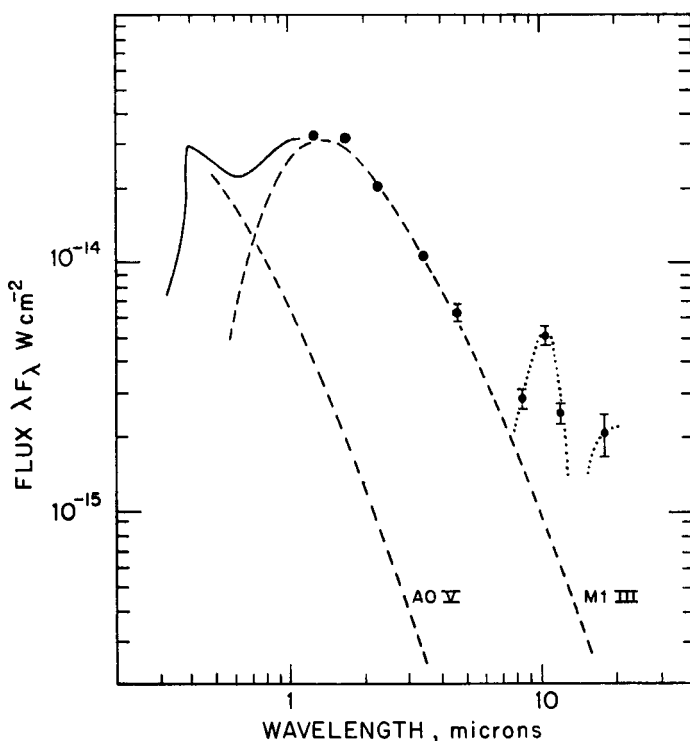


FIG. 1

The energy distribution of the 17 Leporis system in the visible and infra-red. The solid line is taken from Mitchell and Johnson¹². The two component stars are shown dashed; the shell is dotted.

The second category comprises a rather small proportion of Be and Ae stars. Geisel⁵ first drew attention to these. Of the brighter early-type infra-red shell stars, HD 45677 represents one of the most extreme examples, in which 80 per cent of the radiated flux is emitted in the infra-red⁶. The infra-red continuum of the shell stars appears to contain material at temperatures up to about 1200 °K, and generally dominates the stellar continuum longwards of about 2 μm .

17 *Leporis*. Struve^{7,8} and Smith and Struve⁹ reported frequent shell episodes in the early A star 17 *Leporis*. P Cygni hydrogen profiles and metallic absorption lines with high expansion velocities develop during these outbursts, and it was thought that the object was a particularly violent and turbulent shell star. Examining certain inconsistencies, however, five years ago, Widing¹⁰ showed that 17 *Lep* is, in fact, a binary system comprising an M1 giant orbiting the apparently normal A0 dwarf. The separation of the two stars is sufficiently small that at closest approach material from the late-type companion may flow through the inner Lagrangian point to encircle the primary. The A star then drives away the gas by radiation pressure, thus producing apparent shell episodes, although this star is not itself losing mass¹¹.

The photometry of Mitchell and Johnson¹² to $1.1\ \mu\text{m}$ shows nicely the contribution from the M star, whose presence is now well attested spectroscopically. We have measured the 17 *Leporis* system and find that from 1.2 to $5\ \mu\text{m}$ only the M giant contributes. There is no dust shell at a temperature near 1000°K . The colour temperature of the late-type star, 2800°K , is perhaps a little lower than is normal for an M1 giant. Fig. 1 reproduces the visible and infra-red data. Although no hot shell is found, we record a typical silicate-type excess at 10 and $18\ \mu\text{m}$. There is thus, surrounding the system, a cloud of grains which almost certainly originates in the atmosphere of the late-type star.

The almost ubiquitous silicate emission is strikingly absent in α Sco and the VV Cephei stars WY Gem and KN Cas; Gehrz *et al.*¹³ suggest that the faint early-type companions to these stars disperse the supergiants' shells. In the 17 *Leporis* system we find the silicate feature despite the relatively luminous A-type star. Indeed, since M1 giants do not normally exhibit detectable silicate emission, we must in this case attribute the existence of the shell to the presence of the early-type star. Neither star, on its own, would possess circumstellar dust, but in combination they do.

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References

- (1) G. Neugebauer and R. B. Leighton, *Two-micron Sky Survey*, NASA SP-3047, 1969.
- (2) N. J. Woolf and E. P. Ney, *Ap. J.*, **155**, L181, 1969.
- (3) F. C. Gillet, K. M. Merrill and W. A. Stein, *Ap. J.*, **164**, 83, 1970.
- (4) R. M. Humphreys, D. W. Strecker and E. P. Ney, *Ap. J.*, in press.
- (5) S. L. Geisel, *Ap. J.*, **161**, L105, 1970.
- (6) J. P. Swings and D. A. Allen, *Ap. J.*, **167**, L41, 1971.
- (7) O. Struve, *Ap. J.*, **72**, 343, 1930.
- (8) O. Struve, *Ap. J.*, **76**, 85, 1932.
- (9) B. Smith and O. Struve, *Ap. J.*, **95**, 468, 1942.
- (10) K. G. Widing, *Ap. J.*, **143**, 121, 1966.
- (11) A. P. Cowley, *Ap. J.*, **147**, 609, 1967.
- (12) R. I. Mitchell and H. L. Johnson, *Comm. Lunar Planet. Lab.*, **8**, 1, 1969.
- (13) R. D. Gehrz, E. P. Ney and D. W. Strecker, *Ap. J.*, **161**, L219, 1970.